TWO OF THE MOST IMPORTANT FEATURES

YOU CAN INCLUDE IN YOUR EARTH STATION!

POLAR MOUNT

and

ROTATABLE FEEDHORN

PLANS

$10.00

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P. O. Box 5673, Winston Salem N.C. 27103

Thank you for your interest and response to our advertisement. Satellite DXing promises to be one of the most exciting areas of interest in the next decade . Costs are high, but as is explained later, can be considerably reduced. A great deal of innovative development work can be done on an individual basis, and to speed progress, we have to be willing to provide economic justification to those doing this work.

In this paper we want to communicate a practical approach toward assembling an earth station that will perform well. Your first priority should be the acquisition of at least a 10' solid surface dish antenna. They are still available used, but, as more people become aware of these dishes, will become more expensive and difficult to find.

Then you need to support the dish on a polar mount. We spent untold hours designing and building a mount that works well. It is the basic subject of this paper.

In the meantime, you must reach a decision on the amount of money you can allocate to the project. Is your interest purely technical for equipment development and experimentation without the need for good quality pictures? Then you probably can get by with a dish, low noise amplifier, and an experimental receiver at a much lower cost than someone who wants to see good quality pictures. He will have to spend an additional 4 to 5 thousand dollars on a commercial receiver.

The next requirement is the low noise amplifier. For acceptable home use an amplifier with a 1.5db (150°K) or better noise figure is a must. A larger dish relaxes the LNA requirements but the greatly increased cost of the dish, mounting it, and its taking up half your backyard far exceed the relatively slight increase in cost for a good LNA. So, we recommend a commercial LNA with at least a 1.5 db noise figure. There seems to be a back-log of orders for LNAs, so, after you make the decision to proceed, get one on order.

There are a few kits on the market for sections of receivers. Unless you are technically

oriented and have plenty of time, or unless you are primarily interested in experimentation, we can't recommend this approach at the present time. Receiver alternatives are discussed later.

You must have a location for the dish where it can "see" the geostationary arc. Buy an inexpensive clinometer and get a compass. Visit your cable company or PBS TV station and get the coordinates of the various satellites. Or send for a computer generated listing from CATJ (see references). The dish must have an unobstructed look at the satellites - no trees, branches or anything of any significant cross section. Wires, etc. are okay. The dish should be close to your receiver site to minimize feed line losses. You may have to cut a few trees, but it's worth it. You may even have to move!

Building your earth station won't be easy. But when you are finished you will have accomplished something to be justifiably proud of that will bring much personal satisfaction and enjoyment. Good luck!

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In a few weeks, you will receive information on constructing a prime focus feed horn and low noise amplifier support. You will also receive plans for a remote feed horn polarization control that can be built at very little expense. This device has been used for half a year now and is a very useful feature. It permits changing from vertical to horizontal polarization very rapidly and when you are flipping channels, say on Satcom 1 where about half the entertainment is of each respective polarization, it is convenient. You can set the polarization angle half - way between vertical and horizontal, observe all channels and then optimize what you want to watch. Also, the polarization from satellite to satellite varies somewhat and it is a convenient way to peak for a better signal to noise ratio.

If there is enough interest, we are willing to arrange purchase of earth station components at quantity prices. Your comments will be appreciated.

Due to limited time, all questions will be answered by mail. You must include an SASE. We will limit answering questions of a technical guidance nature to those on our customer list. We are anxious to serve you.

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CONSTRUCTION OF A POLAR MOUNT FOR PARABOLIC DISH ANTENNAS

This design has been adapted from field experience. It is to be understood that these are suggestions only and since Satellite Innovations has no control over the application of these ideas, Satellite Innovations will assume no responsibility for actual or consequential damages arising from their use.

SAFETY CANNOT BE OVEREMPHASIZED! When working with heavy (and fragile) components, an error can result in personal injury or loss of the dish. (Expensive). Don't take chances! A pinch hazard exists when working with heavy movable structures and a rushed or overconfident attitude invites injury.

Among our requirements for a polar mount were that it be capable of withstanding moderate wind and ice loads, be low in maintenance requirements, permit the dish antenna to be pointed at any satellite in the geostationary arc with little or no adjustment and be simple and relatively low in cost to construct.

The polar mount described here was designed for a 10 foot dish. The dish had a circular mounting and reinforcement ring about half its diameter, and the mount was attached to the ring at four places. Other dishes will vary in the method of attachment to the polar mount, so it may be necessary to modify the polar axle. We will be glad to suggest a means of attachment for your dish if you will supply a description. Most likely it will be obvious; just try to keep the polar axle as close to the dish as possible and still allow clearance as the dish is moved. At our location, the ice load rarely exceeds half an inch and winds above 70 mph are uncommon. Some of you in more northern climates would be wise to spend a little extra and use an inch or so larger diameter support pipe and scale up the other components. If you are fortunate enough to acquire a 12' dish, you will have to scale up the mount substantially, since you have about 1/3 more surface area to support. This description will apply to a 10' dish.

Throughout the design you are encouraged to use the materials you have available at least cost, and to modify the design to suit your needs. Be sure to buy your metal at the

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the salvage yards. Most everything should be available there at a fraction of new steel prices.

The base for the polar mount was a pipe about 6 1/2" O.D. by 8 feet long set into the ground 4 - 5 feet, or as far as you can dig with a post hole digger. Keep the hole diameter small to reduce the amount of concrete required, ours took two 75 pound bags. The base pipe should be drilled as shown for 4 or 6 large bolts to clamp the inner pipe and prevent its turning. Nuts could be welded to the outer pipe or the holes could be tapped. If you have a 1/2" tap and use 1/2" bolts, you might want to use eight to really lock it into place. The top of the outer pipe should be cut off squarely and smoothly by machine.

The inner, telescoping, pipe should be drilled and a rod or long bolt put through to limit how far it can drop into the base pipe. Rollers could be slipped over the rod ends so that the mount assembly can be turned about the vertical azis more easily, although the only time the assembly will be turned about its vertical axis will be during initial alignment of the polar axle.

A platform is welded to the top of the inner pipe and ours was a steel plate 1" X 8" X 12". It should be reinforced with 1/2" thick gussets as shown. Most of the welding can be done with a 180 - 230 amp Sears welder. Two lengths of heavy (ask for "ship" channel) 4" channel were welded to the top plate on their edges with the hollow "U" sides faced together. Between them fit the polar axle in its lowered position. The 4 inch channels are reinforced with plates where the polar axle pivot bolt passes thru. Let the channels overhang the top plate just enough so that the dish/polar axle assembly can be tilted 90° vertically so the dish is looking out horizontally over the terrain. Assemble the channels and polar axle together with the pivot bolt before welding. Then tack weld the channels to the top plate. Check alignment and for warpage continuously during the welding process.

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The polar axle is supported by a pivot bolt on one end as already described and by the polar axle screw on the other. The polar axle was cut from a 4" basement jack from a building supply place but it's probably less expensive to use a pipe of similar diameter from a salvage yard. It will probably be heavier with greater wall thickness. The length of the polar axle is determined by the type of mounting required by your dish. We feel it is important to provide a good bearing at both ends of the axle since this will be where almost all of the dish movement occurs. Two utility trailer wheel hubs were used. The lug bolts were driven out; and lengths of fine threaded rod (from an industrial supply house) with roller bearings (look in yellow pages under bearings for a bearing dealer) and nuts were fitted to each. The nuts and rod were drilled and cotter pinned so the bearing preload is not lost. Pack the bearings with a high temperature grease. The hubs with bearings and axle rods pinned to them are welded to the polar axle. Tack weld the hubs, check for concentric alignment and finish weld. Do this in steps to prevent overheating and melting the grease from the bearings. You may want to tape or wire a cover to the inner part of the hub to keep dirt out of the bearings. If you don't use trailer wheel hubs, a good alternative would be a double race flange mount pillow block or even a large nylon bushing. You may also want to consider using a piece of square tubing or channel for the polar axle.

One end of the polar axle has a bushing installed to prevent distortion of the axle pipe when the pivot bolt is tightened. The bushing is a piece of heavy wall tubing drilled for a close fit with the pivot bolt, and just slightly longer than the axle diameter. Be sure to locate the bushing to clear the axle bearing hub and the inside nut and cotter pin.

The other end of the polar axle is raised and lowered to obtain the inclination for the dish. The inclination screw, a heavy threaded rod, the bigger the better, is attached to a

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bracket welded to the polar axle. This bracket allows the threaded rod to pivot as the polar axle is raised and incorporates a thrust bearing (1/2" I.D.,about 1/2" thick,and about 1" O.D. About $4.00 at bearing dist.) to reduce and smooth the raising effort. This adjustment is "touched up" a half inch or so when pointing between satellites over 15° or so apart. For locations in the central latitudes of the U.S., the polar axle will be inclined about 45°.

The lower end of the inclination screw is supported by another pivoting bracket attached to the 4" channels. A nut is welded to the bottom of the bracket and the inclination screw is threaded thru it. A knob or handle can be provided on the inclination screw. We used two nuts with a lock washer between them.

The attachment of the dish to the polar axle was by 2 lengths of heavy angle iron, the center of each drilled for a clearance fit of the polar axle stub threaded rods and attached to the four mounting holes on the dish with heavy wall aluminum spacers 8" long and bolts. This attachment will vary from dish to dish and a few points should be kept in mind. Keep the center of gravity of the dish as close to the polar axle as possible. This will reduce the force necessary to move the dish on the polar axle; you may want to remote control the dish and the actuator can be smaller. Make sure that all moveable parts will clear each other at all inclinations and polar angles. Make a few drawings and give some consideration to this to save expense and modifications. If you send information on your dish, we will suggest an attachment method.

A handy tool for drilling large diameter holes in steel with a drill press or 1/2" drill is the hole saw. Sears carries one in high speed tool steel and a cheaper model. Buy the better. Be sure to use a lubricant such as Tap Free (available at industrial supply houses) generously.

The final consideration of the design is positioning the dish at some point about its

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range of movement. A pipe support can be placed between the ground and a bracket installed on the rim of the dish. If the rim is not strong enough to use, extend an arm from the mounting ring. The length of the support is varied to move from satellite to satellite. We just push on the dish and move the pipe support to a different point on the ground.

A remote control system can be devised by using an electric boat winch or hydraulics. If someone would devise a hydraulic system using water pressure to move the acuator, they would make a large contribution.

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THOUGHTS ON SATELLITE RECEPTION

We would like to offer suggestions and express some of our ideas for those of you interested in Satellite TV signals. The use of satellites to relay TV and data of all types is one of the hottest communications innovations ever. Opportunities in the field are unlimited and the amount of programming and its variety have increased greatly in the 6 months that we have observed it. Now you can receive channel 9 from N.Y.C., channel 9 from Chicago, channel 2 from San Francisco and the daddy of it all, channel 17 from Atlanta, plus, Aviation Weather starting very early in the morning for those of you in later time zones (with the Eastern feed for PBS at 7:45 EST), Canadian and Spanish TV, all kinds of movies, the religious networks and more sports than you ever dreamed of. And that's just a small part of it. You are operating your own Earth Station and can point your antenna where and when you want (of course there are certain legal restrictions you should be aware of, that are in a state of flux at this time). Satellite DXing is destined to become extremely popular as time goes on and the excitement is contagious.

What will it cost? Only a few years ago the cost of an earth station was many hundreds of thousands of dollars. You would have needed an acre of land. Costs have steadily come down. Last summer, the cost of a 4.5 meter dish and all electronics was about $16,000. We just got a quote for the equivalent at $14,000. So prices have been dropping, but not terribly fast and probably will tend to level at around $10,000 - $12,000 in a few years (considering inflation and a reduced demand). These prices are for a cable TV grade terminal. If you are interested in private reception, about the only area in which you can cut corners, at this time, is the antenna. Now, a 10' dish and a 120°K(1.5db) noise figure low noise amplifier teamed up with an 8 db threshold receiver will give pictures that are completely

acceptable for home viewing in most parts of the country. A new 10' dish, bare, can be purchased for about $1800. A 120°K LNA costs about $1400. You can go to a larger dish; kits for a build it yourself 16' are about $3000 - $4000. That means the LNA would be less expensive, maybe $900 - $1000. When it all boils down, it's cheaper to go with a good, standard 120°K LNA that you can always sell for nearly what you pay for it (as opposed to expensive LNA kits that become nearly worthless in many cases) and to but or make a 10' - 12' dish. If you think building a polar mount for a 10' dish is a challenge, try to make one for a 16 footer! A gentleman* in Chicago is offering kits for various size dishes. If the surface is accurate, a 10' kit would be the way to go if you have time to build it and live in the large area of the country where the satellite "footprint" is favorable. In a few areas of the U.S., and in Canada and Alaska, the larger dish would be desirable, and it would make sense to build a 14' - 16' one and use a 120°K LNA.

So, buy or build a 10' - 12' dish and bite the bullet and invest in a 120°K LNA. If and the dish will most likely hold their value as well as U.S. savings bonds when all economic factors are considered. And you can enjoy your earth station! If you already have a dish smaller than 10' sell it for as much as you can get because it won't do you any good for satellite TV reception.

We now have to consider the receiver. If there is enough interest, we can design and manufacture a receiver for around $2900 that will have a low threshold and be fully tunable. You could sit in your easy chair and remote tune the receiver. Meanwhile, the least expensive quality receiver is Microdyne's at $3200. It is a single channel unit and a mechanical filter must be adjusted when changing channels (a pain). Hughes has a 24 channel receiver with a very low threshold for $4700. Both of these will hold their value

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well and could be resold to the cable industry if a person wanted to recover some of their investment. (But once you have an earth station you still find it hard to part with). Rumor has it that there will be some lower priced receivers coming along but they aren't yet on the market to our knowledge.

Now, we are talking about a dish for $1500, a LNA for $1600 and a receiver for about $4000. Total $7100. That's half the going price for a similar commercial system. How can the cost be further reduced? Ten foot dishes are popular with phone companies and others using microwave links and, lucky for us, the FCC is requiring improved directionality dishes be used. So these companies are scrapping many of the old ones. We found a 10 footer for $100. But they are going fast so as soon as you read this, start looking and latch onto any decent ten footer you can find and pay between $500 and $1000 for it if you have to. Start with the phone company, AT&T, scrap metal dealers, surplus sales. Get contacts at places that use microwave equipment (look on towers and tall buildings) and offer a finders fee. Talk to friends and friends of friends. You will have to make your breaks by doing some legwork. Hold out for a solid surface dish. If it has dents, it will probably work okay as long as they aren't too bad. It is easier to repair them than to make a dish - cheaper too. (You can use the dents to bargain for a lower price). Be sure the dish hasn't been distorted overall. Stand back a distance and sight along the near and far rims and line them up. An inch or so shouldn't make much difference in performance.

Now let's look at cost again. Say you found a dish for $500, bought a <u>good</u> LNA for $1600 and a receiver for $4000 . You're in business for $6100. If you indicate sufficient interest we will manufacture a quality continuously tunable receiver for about $2900 and set up a quantity purchase arrangement for LNA's at about $1500. Now we are below $5000 for the components of an earth station. And, more important, it's $5000 in the bank. You

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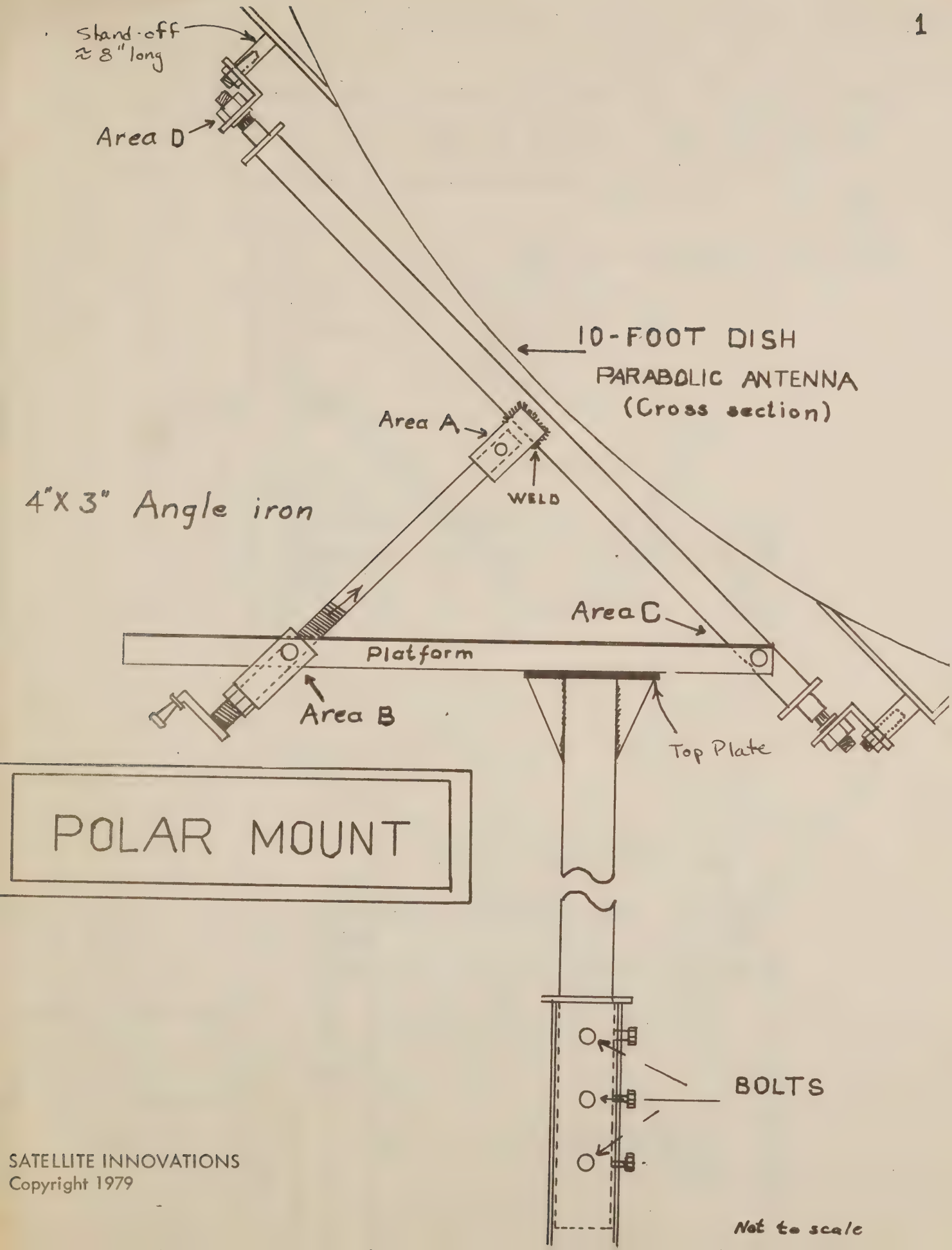
can probably sell it for more than you paid for it! Which leads us to another thought.

Suppose you became a dealer for one or more components of an earth station. Or use it for business purposes. Now you have a tax write off and are eligible for investment tax credit. So, your $5000 system only costs you $2500 - $3000 over a five year period, plus you have a chance to get into a new money making business. More ideas anyone?

REFERENCE

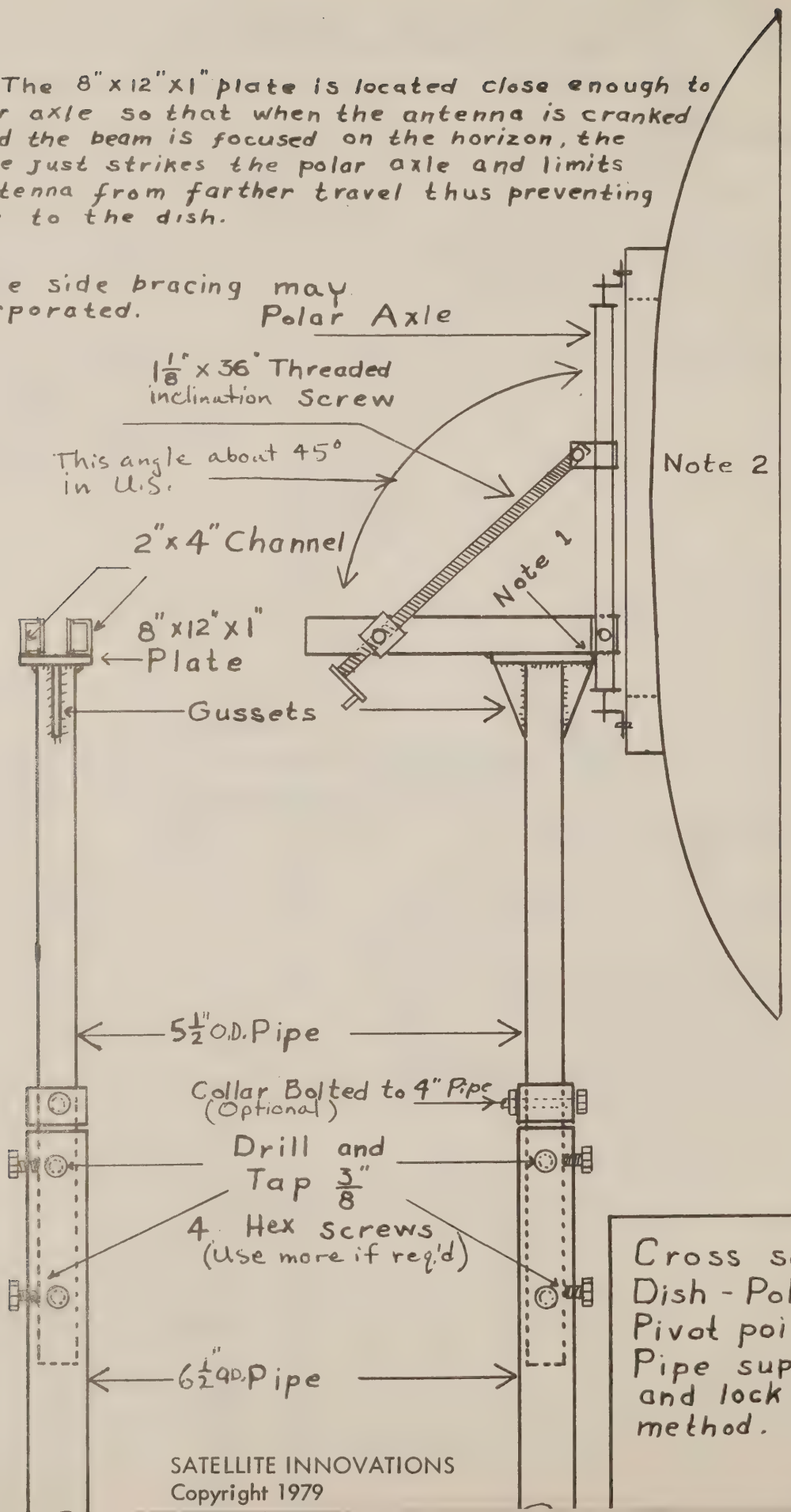
CATJ, 4209 NW 23rd, Suite 106, Oklahoma City, Oklahoma 73107.



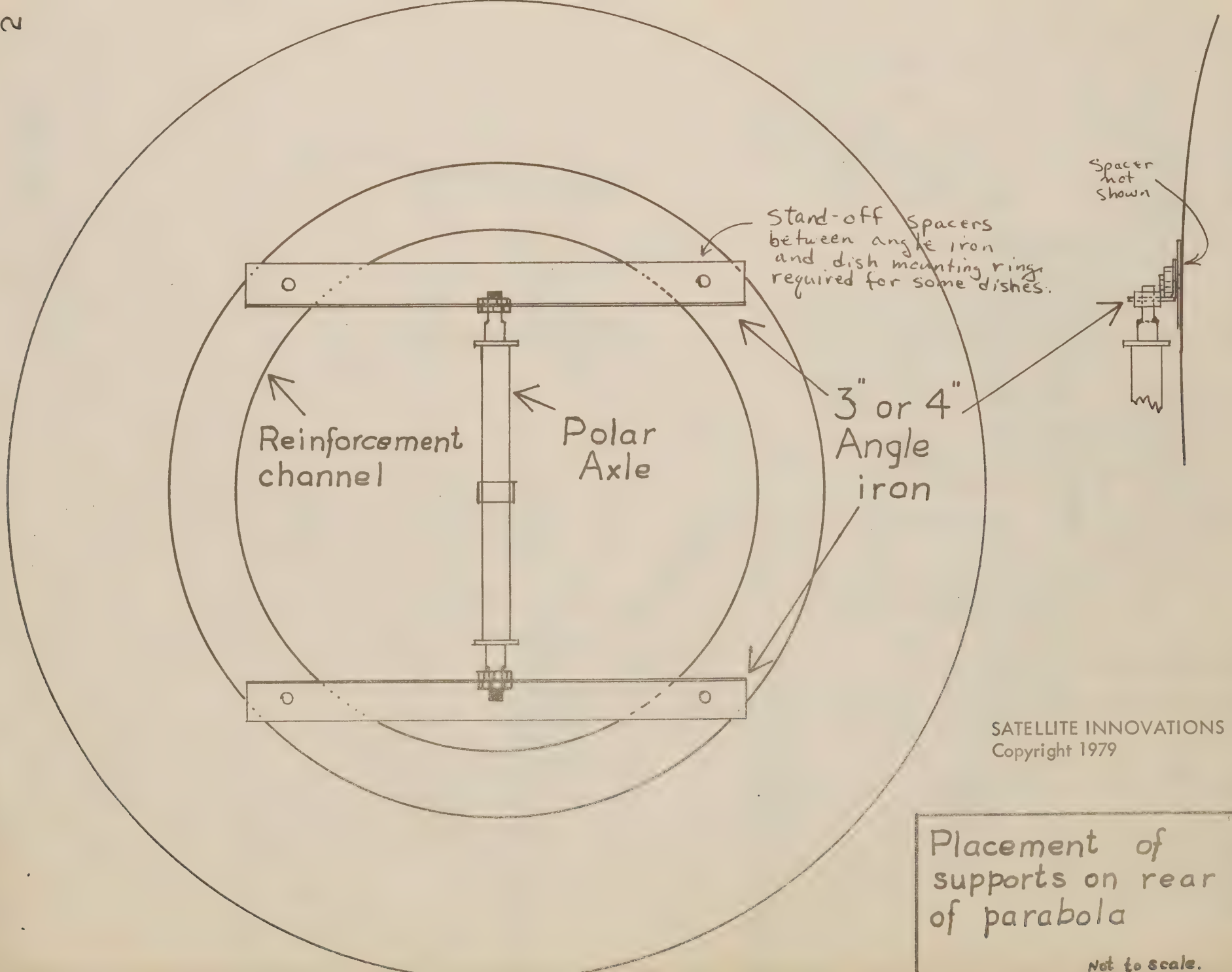
POLAR MOUNT

Note 1 - The 8" x 12" x 1" plate is located close enough to the polar axle so that when the antenna is cranked down and the beam is focused on the horizon, the 1" plate just strikes the polar axle and limits the antenna from farther travel thus preventing damage to the dish.

Note 2.
Suitable side bracing may be incorporated.

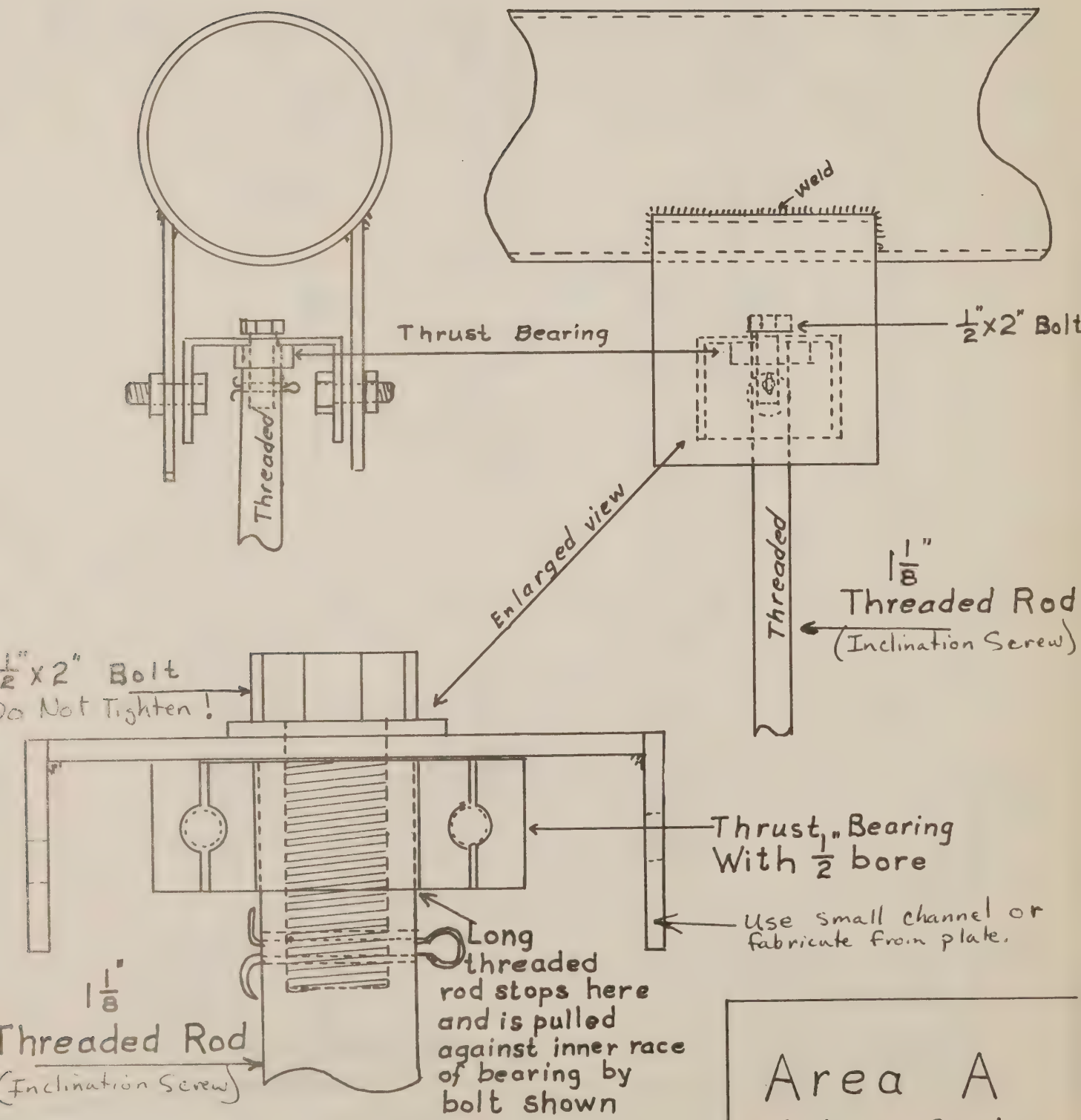


Cross section of Dish - Polar mount - Pivot points - Pipe support and locking method.

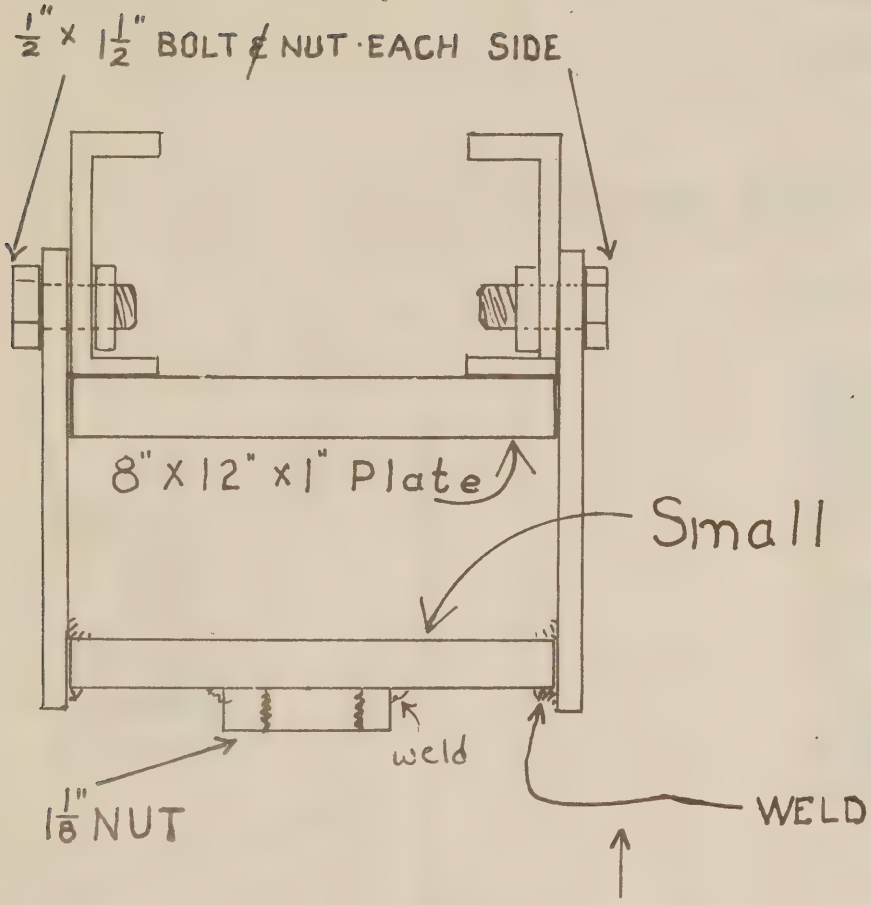


Placement of supports on rear of parabola

Not to scale.

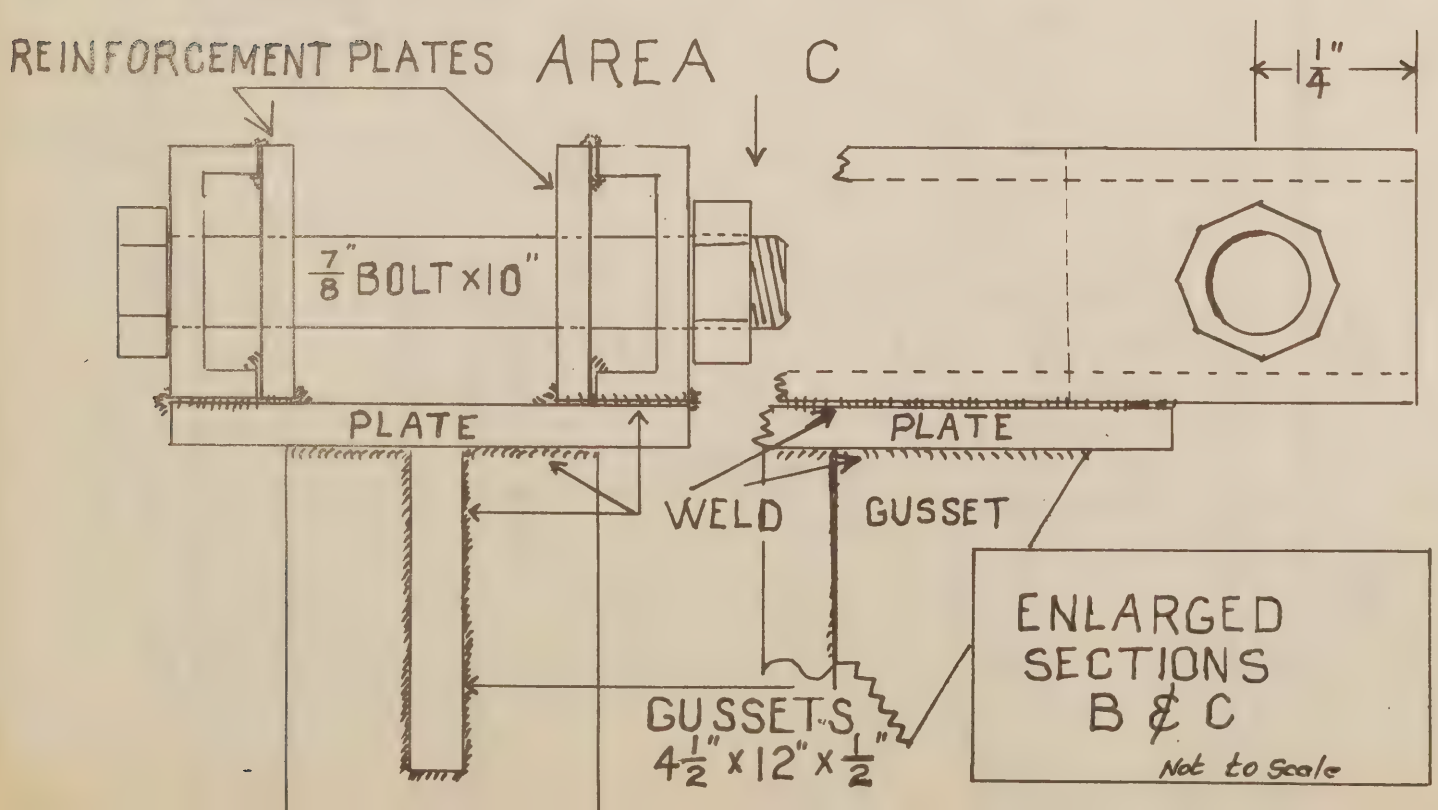


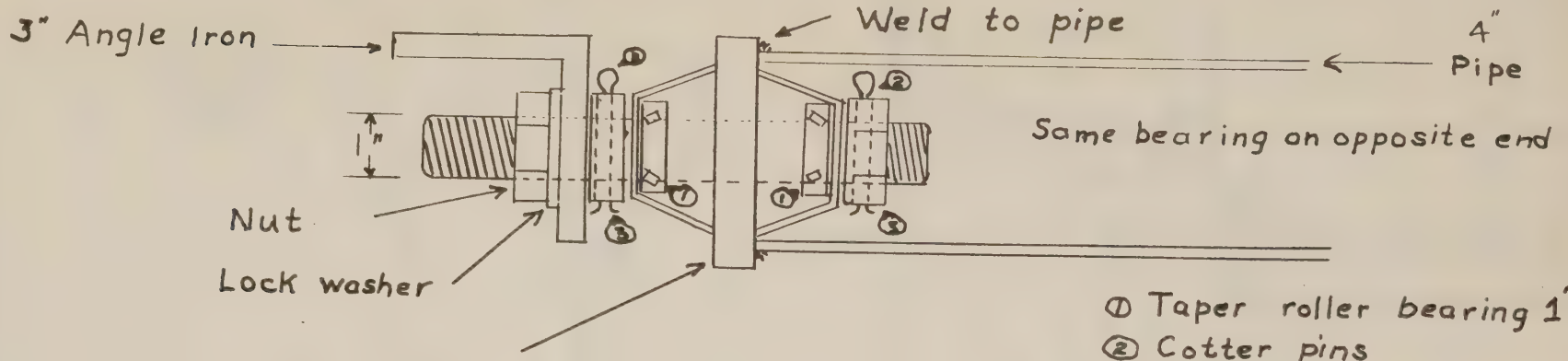
Area A
Not to Scale



AREA B

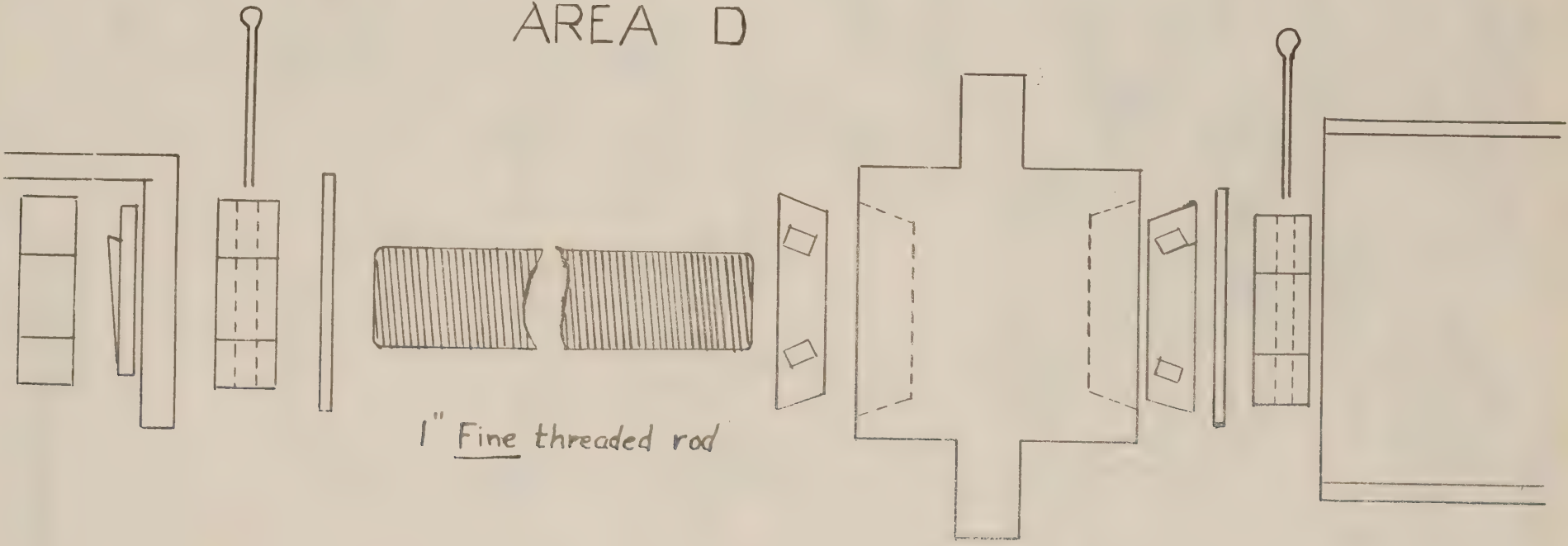
AREA C

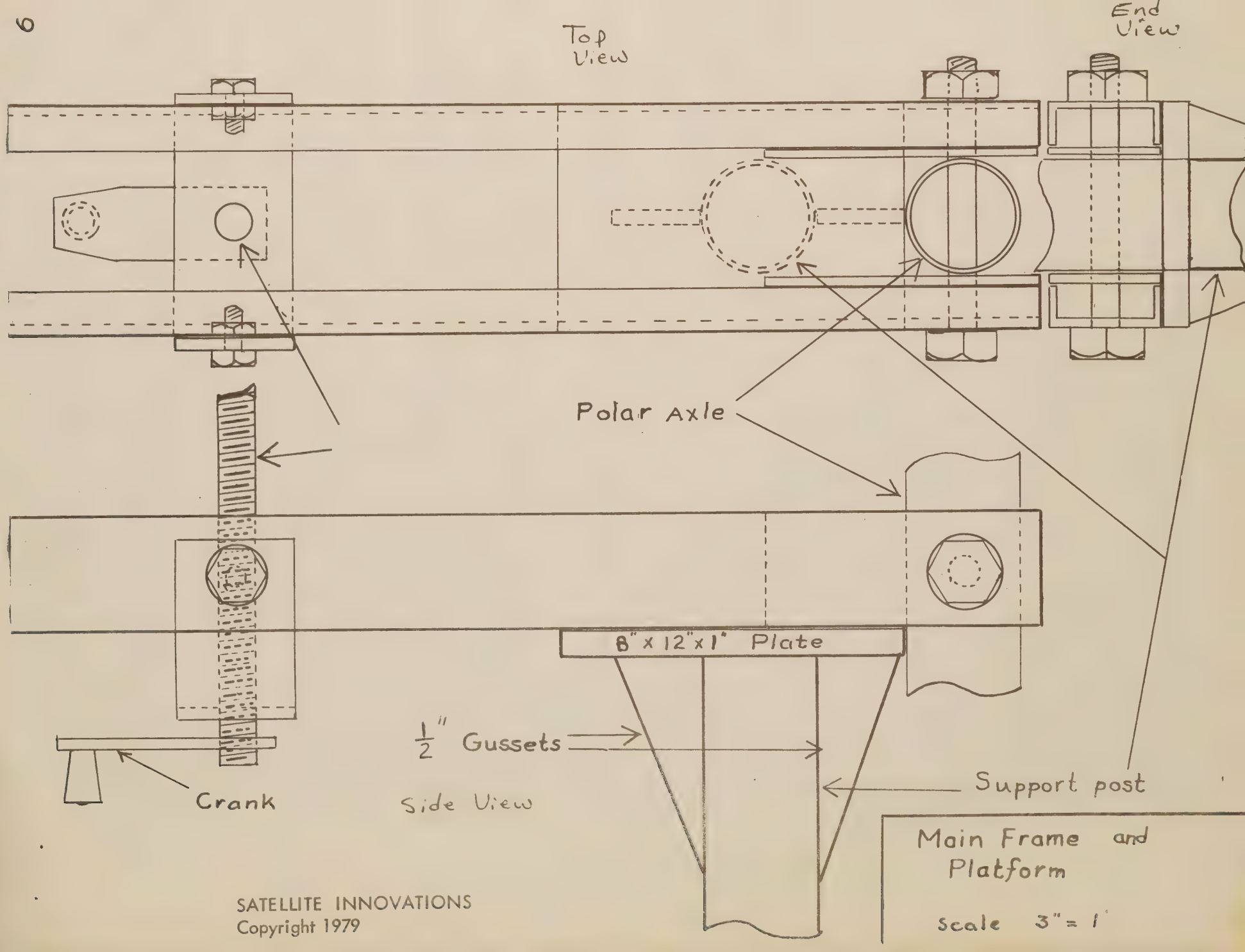




Inexpensive light trailer hub $5\frac{1}{2}$" O.D. 4-lug

AREA D





Main Frame and Platform

Scale 3" = 1'

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We hope the polar mount plans have been useful in helping you construct your private earth station. A few points of interest since the plans were written. Low noise amplifiers are coming down in price to the $1400 and even $1000 range for a 120°K noise figure. AVCOM of Virginia* has announced a satellite TV receiver with many desirable features in the $2000 - $3000 range and is looking for individuals to act as dealers and represent their product. Jim Vines of Paraframe** will probably make an 11' dish antenna available and this size would be a very good compromise. A $5000 terminal that is of almost commercial quality is now a reality.

As we promised, we have enclosed plans for your rotatable feed horn assembly. Since it was designed last fall this assembly has proven to be the most useful feature of our earth station (aside from the polar mount). It's useful because so much programming is on both polarizations and to eliminate the expense of two LNA's and an ortho-coupler, a mechanical device is needed to rotate the feed horn about it's axis of symmetry. The horn must remain positioned at the focal plane of the dish.

The answer was to use a standard TV antenna rotator supported beyond the focal plane, to turn the LNA and attached feed horn. The feed horn can be rotated 90° in about 15 seconds. All transponders can be observed simultaneously if the feed horn is rotated half way between vertical and horzontial polarizations. In addition, the feature is great to have when you are orienting the dish, running tests, and compensating for different satellite polarizations. Remember, the LNA is going to be difficult to reach when the dish is pointing at a satellite.

We are offering a design that works well for us. You may want ot modify it to suit the materials you have.

First consider how the LNA, rotator etc. can be supported at the focal point. We used four pieces of 1" electrical conduit about 7' long with 5/16" threaded rod down the inside to pull the dish, conduit, and rotator mounting plate together. Ends of the conduit can be mitered on a table saw (with a metal cutting blade from Sears) to mate with the contour of the dish. Use nuts and washers to keep the threaded rod centered in the conduit. Save the ends that are mitered off the conduit to mate against the back surface of the dish so the nut on the threaded rod has a square surface to pull against. You will need to make bushings to put into the conduit at all ends to keep the rod square and centered. This is important. Cut them from heavy aluminum plate with a hole saw or have them turned on a lathe. The rotator mounting plate has its four corners bent at the proper angle to meet the conduit squarely. All the dimensions vary with the diameter and focal length of the dish.

The rotator "floats" in nylon bearing plates attached to both rotator mounting plates; i.e. the tube the rotator turns is supported by the nylon bushings. Two collars made from short lengths of aluminum tubing (with an I.D. just greater than the O.D. of the tube the rotator turns) are slipped over that tube at each end of the rotator. A clearance hole is provided in both plates. It is slightly larger in diameter than the hole in the nylon bushing. Sears hole saws are invaluable in fabricating these parts. The plates are held together by two pieces of tubing and lengths of 5/16" threaded rod. Locate the smaller tube to clear the rotator and the larger one to fit between the studs of the rotator. Two short lengths of rubber tubing are slipped over adjacent rotator studs to take up movement and quiet the operation.

A slip joint is provided to allow adjustment of feed horn to focal plane.

LNA geometry varies but an offset attachment as shown can be used. The horn must rotate on its axis of symmetry. A small plate is inserted into a slit in the tubing to lock the plate to the tube.

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Alignment of the feed horn assembly is as follows:

1. Lower dish on polar mount ot convenient working position.
2. Remove LNA support tube and LNA.
3. Bore sight down through rotator to target centered target in hole.
4. Adjust tension on threaded rods in conduit to center target in hole.
5. Place reflective aluminum tape on dish at a couple of points.
6. Support a cardboard screen where you think focal plane is.
7. Point dish directly at sun until shadow of mounting plate is centered on dish.
8. Observe at what point the reflections from the tape converge by moving screen in and out.
9. You now have the focal point defined and the support aligned.

Use a length of RG-214 (RG-213 is cheaper and probably will work as well, try even good RG-8U) to run between the LNA and receiver. We use almost 100 feet of RG-214 and have enough signal! Use large nylon cable ties to clamp the cable to LNA to prevent any motion at LNA coax connector. This is important. A plastic trash bag covering the LNA will help protect it. You may want to install an alarm system on the assembly somewhere with camera, etc.

We hope these ideas are useful to you. Write and let us know of your progress and if you would like any other plans.